Curved Retrograde TTC Fusion Nails: Neurovascular Structures at Risk and Entry Point Safe-Zone
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Introduction/Purpose: Retrograde intramedullary nailing is an established surgical procedure for tibiotalocalcaneal (TTC) fusion. The clinical incidence of plantar neurovascular damage secondary to TTC is poorly reported. Neurovascular structures at risk include the lateral plantar nerve and artery and first branch of the lateral plantar nerve. Curved TTC nails with lateral entry points theoretically reduce the risk of injury. The purpose of this study was to assess the incidence of iatrogenic injury to the plantar branches of the tibial nerve and posterior tibial artery and to propose a neurovascular safe-zone regarding entry point of retrograde TTC fusion nails.

Methods: Ten below-knee thawed fresh-frozen cadaveric specimens were used in the study. None had gross deformity or malalignment of the hindfoot. Ankle and subtalar joints were not prepared before nail insertion but were maintained in neutral dorsiflexion and 5 degrees of valgus of the hindfoot. Surgical technique followed specific technical steps described for the T2 Ankle Arthrodesis Stryker nail (Schonkirchen, Germany), measuring 11 mm diameter and 200 mm long. Shortest distance between the nail and the main plantar neurovascular branches and injured structures were recorded during dissection. We also evaluated the relative position of these branches as they crossed two different lines: a longitudinal line connecting the most posterior point of the plantar surface of the calcaneus (Point A) to the base of the first metatarsal (Point B) and a transverse line connecting point B to the base of the fifth metatarsal (Point C).

Results: Shortest distance between the nail and main branches of the plantar neurovascular bundle: medial plantar nerve 21.5mm (17.7-25.2), lateral plantar nerve 4.7mm (2.2-7.1), Baxter’s nerve 6.6mm (2.1-111) and lateral plantar artery 1mm (0-2.7). Lateral plantar artery was found to be in direct contact with the nail 70% of the time, 30% with a macroscopic laceration. Baxter’s nerve and lateral plantar nerve were injured in 20% of the cadavers. The medial plantar artery and nerve were not injured. Position of the structures in AB line, from proximal to distal: Baxter’s nerve (33.5%), lateral plantar artery (39%), nail (42%), lateral plantar nerve (47%) and medial plantar nerve (63%). Distance from point B in the line BC was respectively 26% and 56% for medial and lateral plantar nerves.

Conclusion: Our cadaveric anatomical study shows that the most common structures at risk for iatrogenic injury by lateral curved retrograde TTC fusion nails are the lateral plantar artery, lateral plantar nerve and Baxter’s nerve. The proposition of a true neurovascular “safe-zone” is difficult to ascertain given individual anatomic variations. More lateral entry points would decrease the risk of iatrogenic injury to these structures. We propose that a longer plantar longitudinal approach (4-5 cm) and blunt dissection performed deeper to the plantar fascia would decrease risk of plantar neurovascular structure injury by the nail.
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**Anatomical dissection: Tibial Nerve Branches**
- A - Gastrocnemius Branch
- B - Sural Nerve
- C - Lateral Plantar Nerve
- D - Medial Plantar Nerve

**ANATOMICAL LANDMARKS**
- A - Posterior Aspect of Calcaneal Tuberosity
- B - Base of the 1st Metatarsal
- C - Truncus of 5th Metatarsal

**Relationship of Retrograde Nail and Plantar Neurovascular Branches**
- Green - Sural Nerve
- Blue - Lateral Plantar Nerve
- Yellow - Lateral Plantar Nerve
- Orange - Medial Plantar Nerve